Growth rates of subalpine fir (*Abies lasiocarpa*) in the inland Northwest Idaho Deas indicators of balsam woolly adelgid (*Adelges piceae*) infestation

Madison Pettersen-Bradford[1], Kurt Kipfmueller[1], Erika Eidson[1,2], Laura Lowrey[3]
University of Minnesota[1], Idaho Department of Lands[2], United States Forest Service[3]

Questions

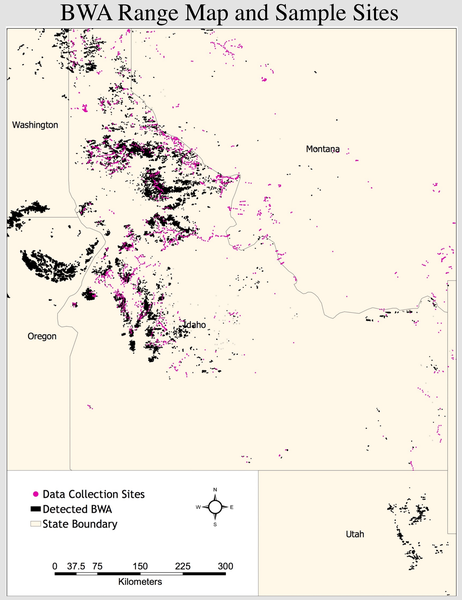
1. Does initial feeding by BWA initiate a positive growth response in firs that can be used to pinpoint the timing of initial BWA outbreaks?

2. How does BWA feeding impact growth rates of infected trees and over what duration?

Study Area and Background

Originally from Europe, Balsam woolly adelgid (BWA), was introduced to the eastern US in 1929 (Ragenovich and Mitchell, 2006). It has decimated fir-dominated forests over the last 50 years, resulting in substantial ecological change and increased wildfire risk (Lowry, 2015). In the western US, BWA is a more recent addition, first discovered in northern Idaho in 1983 (Lowry, 2015). Since then, BWA have expanded their range, with new infection centers discovered in Utah just last year.

BWA Range Map and Sample Sites



BWA feed on the cambium of true fir trees which causes abnormal cell division. This results in problems with water conduction throughout the tree ultimately leading to gradual loss of tree vigor and eventually death (Raganovich and Mitchell, 2006).

BWA indicators

BWA infestation appears in various forms. Visual indicators include white, cotton-like attachments on main bole or gouting on branches.

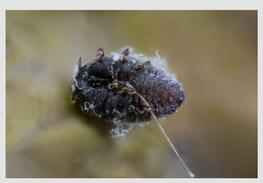
Picture 1: BWA on stem of tree. Appear as cotton-like patches. Photo from Idaho Department of Lands

Picture 1

Picture 2

Picture 2: Gouting is an indicator of BWA that appears on the branches of fir trees. It creates bulges of the cotton-like material especially on the nodes of small branches.

Picture 3: Adult female BWA. This all female insect reproduces asexually, or parthenogenically. They remain in at their injection site and reproduce at site forming cotton-like structures for their eggs.



Picture 3

Methodology

- Increment cores were collected from multiple fir (host) and non-fir (non-host) trees at each plot location.
- Information such as height, DBH, degree of infestation, and species were recorded at plot location.
- Cores were separated by degree of BWA infestation (0 - 4) and non-host species identified at each monitoring plot.
- Annual growth rings from increment cores were measured using the Velmex sliding stage micrometer under 40x magnification to the nearest 0.001 mm.
- Data Analysis performed using raw tree ring width measurements and plot location data.

Results

Averaged Raw Radial Growth (1779-2018)

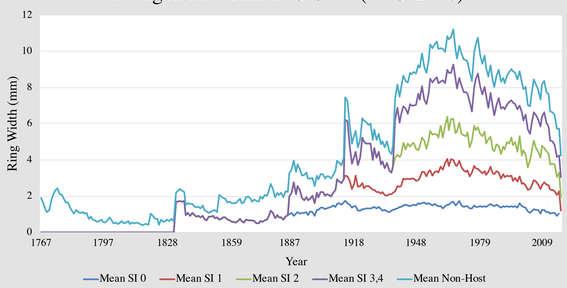


Figure 1: Line graph that shows the mean annual ring width per year by degree of infestation.

Normalized Ring Width Data

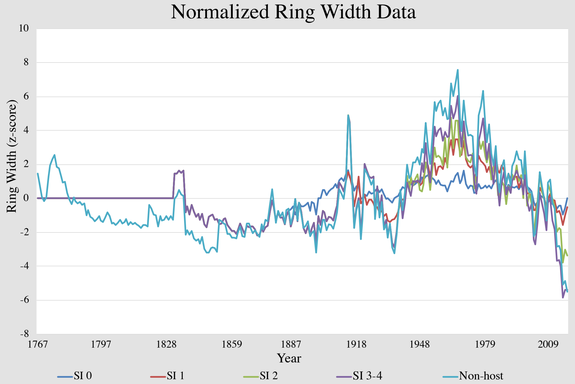


Figure 2: Line graph of the z-scores for the means of each year. This graph standardizes the data so each group is represented from a value of 0. After standardization, a similar but less exaggerated pattern exists between each degree of infestation.

Ring Widths Before and After BWA Presence (1983)

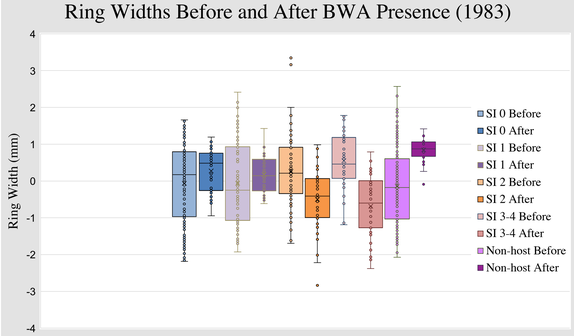


Figure 3: Box and Whisker plot comparing the normalized ring width data after known infestation in the area in 1983. Each degree of infestation is separated by color, the darker color of the two represent ring widths after infestation. In general, there is a negative trend in annual ring widths except for the non-host species.

Conclusion

Question 1:

- Mean raw radial growth (Figure 1) shows that the higher the BWA severity, the larger the rings, supporting the hypothesis that BWA initiates a positive growth response in annual rings.
- However, once the mean raw radial growth data was normalized by converting the means to z-scores (Figure 2), there was no clear pattern that indicated a positive growth response in BWA infested cores.
- The non-host group of cores have the largest ring widths (Figure 2). This could be a result of more available water due to cambium abnormalities in BWA host species, or it could be a result of climactic or other forest dynamics.

Question 2:

- Exact years of BWA infestation are unknown for each core, therefore the year that BWA was first detected in the area, 1983, was used as the threshold for comparison between the ring widths before and after infestation (Figure 3)
- It is thought that BWA presence increases annual ring widths, however after 1983, the overall radial growth was negative. There was, however, a very brief period of growth initially (Figure 2), which could be BWA related or influenced from other climactic or forest dynamics.
- Different from all the host trees, the non-host trees had significant growth after the invasion of BWA (Figure 3).

Acknowledgements

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References:
Raganovich, Iral R. and Mitchell, Russel. (2006). Balsam Woolly Adelgid. *Forest Insect and Disease, 188,* 1-11.
Lowrey, Laura (2015). Monitoring High Severity Damages to Subalpine fir-Dominant Forest Caused Balsam Woolly Adelgid on the Boise and Payette National Forests. Reports from the Forest Health Protection of the Boise Field Office.